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AGRICULTURAL NEWS LETTER

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This issue contains:

THE STRAWBERRY ROOT WEEVIL AS A PEST OF CONIFERS IN THE NURSERY PLANTINGS INVESTIGATED IN NEW YORK

EDITOR'S NOTE:- At the New York meeting of the Association of Economic Entomologists, Dr. Gambrell read an interesting paper titled "The Strawberry Root Weevil, Brachyrhinus ovatus L. as a Pest of Conifers in the Nursery Plantings." This valuable contribution is presented here. In the November, 1934, issue of the Agricultural News Letter, there appeared a paper on "The Alfalfa Snout Beetle, Brachyrhinus ligustici L., by Dr. P. W. Claasen, Cornell University Agricultural Experiment Station. Another paper, contributed by Dr. Harry F. Dietz, discussed Brachyrhinus ligustici L. and Brachyrhinus (formerly known as Otiorhynchus) sulcatus Fabricius. It was printed in the December, 1934, number of this publication.

By F. L. Gambrell, Division of Entomology,
New York State Agricultural Experiment Station,
Geneva, New York.

For over half a century the strawberry root weevil has been regarded as a pest of strawberries in certain parts of the United States and Canada. However, it has only been within comparatively recent years that this insect has received much attention as a pest of evergreens in the seedbed or nursery planting. From our observations during the past five years we have found that this insect is present, at least to some extent, in many of the nurseries of western New York, even tho the presence of the weevil or its injury may have escaped the attention of some nurserymen. There are several species belonging to the genus Brachyrhinus which occur in New York. These are B. ovatus, B. sulcatus, B. rugosostriatus, and B. ligustici. The latter species is of recent occurrence and is apparently limited to Oswego and Jefferson counties as a pest of alfalfa. B. rugosostriatus, B. sulcatus, and B. ovatus attack strawberries and the two latter species also are injurious to evergreens in the nursery planting. Not infrequently both B. ovatus and B. sulcatus may be found together attacking Japanese Yew. On most species and varieties of evergreens attacked, with the possible exception of Japanese Yew, B. ovatus is the most injurious species.

The strawberry root weevil has a very wide list of host plants. Besides attacking most of the evergreens commonly grown in nurseries it also occurs on wild strawberry, many shrubs, brambles, and other plants. In the nursery planting the strawberry root weevil has been most common and injurious on hemlock and various varieties of American arbor-vitae. Of the latter, pyramidal, Rosenthali, globe, elegantissima, umbraculifera, and Douglasi spiralis have been most seriously injured. In some instances it has also been injurious to transplants or lining-out stock of white, Norway, Servian, and Colorado blue spruces and to

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American arbor-vitae, Scotch, Austrian, Mugho, and white pine. It has also been found to a lesser extent on various species and varieties of Juniperus.

Injury by the strawberry root weevil can be classified into two types; namely, that caused by the larvae to the roots and that caused to the foliage and branches by the adults. Larval injury consists of their feeding on and destroying the root hairs and smaller roots and damage to the surface of the larger roots, usually near the base of the tree. Such injury reduces the vigor of the tree and causes it to assume an unhealthy and yellowish appearance. This condition is particularly noticeable on hemlock, and in most cases the root system of hemlock suffers to a greater extent from larval injury than does arbor-vitae. This may be explained in part by the type of root system which characterizes these different trees. The adults feed on the parts above ground and the type of injury appears to vary somewhat with the species of tree in question. For example, adult feeding on hemlock consists primarily of injury to the needles, whereas on arbor-vitae the weevils feed on the new growth and girdle the branches. This latter type of injury is of particular concern to the nurserymen for the reason that it frequently causes the branches to die and necessitates additional pruning practices to remove the yellowed, dead branches in order to have attractive plants to offer for sale.

Seasonal History

Since the process of emergence of the weevils and the period prior to oviposition are both directly affected by seasonal conditions, type of soil, topography, drainage, etc., it is difficult to set a definite date for the application of poison bait or spray. These facts are determined by examining the soil around and under the infested trees. Generally speaking, the weevils begin to appear in the soil about the second week in June, and most of the pupae have transformed to adults by the first of July. The following table shows the rate of development in the life history of the strawberry root weevil during 1936. Altho there is usually some variation in rate of development from season to season, this date is rather characteristic for the species.

Table 1. - Seasonal History of Strawberry Root Weevil (B. ovatus) 1936.

Date	Per cent larvae	Per cent pupae	Per cent adults
May 22	100	0	0
May 28	78	22	0
June 3	47	53	0
June 11	10	63	27
June 18	4	38	58
June 24	0	3	97
June 30	0	2	98

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Control

The control of this insect, particularly as a pest of strawberries, has occupied the attention of entomologists for many years. During this period such practices as flooding, barriers, trapping, soil fumigants, influence of weather, parasites and diseases, cultural practices (including clean cultivation and crop rotation) and more recently the use of poison baits and sprays have received attention. None of these early methods proved entirely satisfactory, altho cultural practices probably afforded the best control of any procedure prior to the use of poison baits and sprays. It has only been within recent years that the control of this insect as a pest of nursery stock has received much consideration.

Present practices for the control of this pest in the nursery depends entirely upon poisoning the weevils with baits or sprays prior to the egg-laying period. To accomplish this it is quite essential to have a knowledge of its life history, particularly as regards the emergence of the weevil from the soil and the length of the pre-oviposition period. The bait or spray should be applied under the trees when from 75 to 95 per cent of the insects are in the adult stage. This date conforms fairly well with the second regular picking of midseason varieties of strawberries. In our experimental work various types of poison baits have been tested. These include bran-molasses, bran-oil, raisins-shorts, bran-sawdust (equal parts)-molasses, and sawdust-molasses mixtures in which calcium arsenate, lead arsenate, or sodium fluosilicate were incorporated in the mixture. The bran-molasses bait was composed of 100 pounds bran, 2-4 gallons of molasses, 5 to 8 gallons of water, and 5 to 8 pounds of poison. The bran-oil bait consisted of 100 pounds bran, 2 gallons lubricating oil, and 5 pounds of poison. The spray mixtures contained 4 - 6 pounds of calcium arsenate in 100 gallons of water and either "Gardinol" sodium lauryl sulfate, calcium caseinate, or lignin pitch (Goulac) as a spreader. The following table shows some of the results obtained with these various treatments mentioned above.

Table 2. - Results of Various Treatments for the Control of the Strawberry Root Weevil.

Treatment	Year	Date applied	Date counted	Per cent efficiency
Spray				
Calcium arsenate, 6 pounds to 100 gallons IN-181, lignin pitch or cal. caseinate spreader(2-8 oz.)	1934	July 2	July 13	92
Baits				
Bran-molasses-calcium arsenate 8%*	1934	July 2	July 6	93
Bran-molasses-calcium arsenate 5%	1936	July 6	July 10	93
Bran-molasses-lead arsenate 5%	1936	July 6	July 10	82
Bran-molasses-sodium fluosilicate 5%	1936	July 6	July 10	97
Bran-oil-calcium arsenate 5%	1936	July 6	July 11	68
Bran-oil-lead arsenate 5%	1936	July 6	July 11	74
Bran-oil-sodium fluosilicate 5%	1936	July 6	July 11	79
Bran-oil-sodium fluosilicate 5%	1935	June 28	July 5	94
Bran-oil-calcium arsenate 6%	1935	June 28	July 5	70
Bran-oil-sodium fluosilicate 5%	1935	June 28	July 5	94
Shorts-raisins (50-50)-sodium fluosilicate 5%	1936	July 13	July 16	93
Bran-sawdust (50-50)-molasses-sodium fluosilicate 5%	1936	July 13	July 17	60
Sawdust-molasses-sodium fluosilicate 5%	1936	July 13	July 17	22

* Refers to per cent poison in the mixture.

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Summary

To summarize briefly the following may be said regarding control:

1. Poison-bran bait containing 5 per cent or more of poison has been quite effective in killing the weevils. This is one of the most satisfactory treatments available at the present time.

2. Generally speaking, calcium arsenate and sodium fluosilicate have given slightly better results than lead arsenate in the baits, altho in some instances lead arsenate has been more effective than calcium arsenate. Likewise, sodium fluosilicate on the whole has proved more effective than calcium arsenate.

3. Bran-oil bait has not proved quite as effective as the bran-molasses mixture, but apparently does hold some promise as a treatment for the reason that it does not dry out so rapidly during hot, dry weather as does the bran-molasses mixture and also molds less readily during wet weather.

4. The shorts-raisins-sodium fluosilicate bait mixture, now in use by Dr. A. B. Buchholz of the New York State Department of Agriculture and Markets for the control of the alfalfa snout beetle (*Brachyrhinus ligustici*), has also proved quite effective in controlling the strawberry root weevil, even after being held in cold storage (35° F) for two months.

5. Spraying with calcium arsenate, while not generally considered by most workers to be as effective as bait in the control of this insect on strawberries, shows promise as a control measure for this insect on evergreens in nursery plantings.

6. Treatments are designed to poison the adults before egg-laying begins. In our experiments we have obtained good control with bran-molasses baits from the last week in June to the middle of July. The time of application conforms roughly with the second regular picking of mid-season varieties of strawberries.

THIODIPHENYLAMINE IN MOSQUITO LARVICIDES PROVES TO BE AN EFFECTIVE NEW INGREDIENT

EDITOR'S NOTE:- This is a reprint of a paper contributed to the "Journal of Economic Entomology, "Vol. 29, No. 6, by Mr. G. Allen Mail, Montana Agricultural Experiment Station, Bozeman, Montana. The title of this interesting paper is "Thiodiphenylamine - A New Ingredient of Mosquito Larvicides."

Thiodiphenylamine, or phenothiazine as it is also known, is a milky green rhombic substance with the formula $S(C_6H_4)_2NH$ and a molecular weight of 199.14. It is very soluble in benzene and acetone, soluble in ether and slightly soluble in alcohol. This material has been considered in recent months as an insecticide against fruit-tree pests, and certain preliminary experiments have been carried out at the Montana experiment station to test its value as an ingredient in mosquito larvicides.

Thiodiphenylamine as a larvicide was first tried out by the writer in a field laboratory during the summer of 1935. In the initial experiments, it was used as a dust, as a dust diluted with 95 per cent road dust, and added to kerosene spray. In these initial experiments only 10 larvae were used in stender dishes. Table 1 gives some typical results.

This initial work showed that the thiodiphenylamine was not as lethal in its action on mosquito larvae as was either the road-dust mixture or the kerosene mixture. Many more preliminary tests were run, thiodiphenylamine in various combinations being tested against kerosene, lubricating oil, crank-case drainings and diesel-engine fuel oil, and in every case the addition of thiodiphenylamine (TDPA) resulted in a more toxic product.

During the six weeks covered by these tests the opportunity was afforded of making some tests in natural breeding places. Rainfall was chiefly in the form of thunder showers, and following such precipitation every depression in the prairie was filled with water. In the larger depressions the pools remained sufficiently long to allow myriads of mosquitoes to mature, usually about eight days. In these pools, as in the laboratory, observations showed again the superiority of oils with thiodiphenylamine added compared with the same oils without this material. This applied only to larvae. Against pupae no increase in lethal effect was noted.

During the winter months more exact tests were continued at Bozeman. Through the courtesy of Dr. W. V. King an abundant supply of material was available from Florida. Thiodiphenylamine in combination or alone, was tested with about 50 other larvicides. Diesel-engine oil, furnace fuel oil and crank-case drainings were finally concentrated on. When added directly to these oils thiodiphenylamine did not completely dissolve. Apparently, however, the toxic

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element in the thiodiphenylamine was soluble, since the supernatant liquid after an oil-thiodiphenylamine mixture had stood for 24 hours was just as toxic as the freshly made and constantly agitated mixture. Thiodiphenylamine dissolved in acetone and this added to an oil produced a mixture that was no more toxic than the supernatant liquid referred to above.

No tabular data are included here for tests with crank-case drainings. This material is not considered a suitable larvicide for use under Montana conditions because of its poor spreading qualities, its lack of toxicity and its variability in composition. Its chief merit lies in its cheapness and availability. Addition of 5 per cent cresoap improved its spreading qualities and the further addition of 1 per cent thiodiphenylamine greatly increased its toxicity. Nevertheless, on account of its lack of uniformity in composition, crank-case oil was discarded and diesel fuel oil substituted. Tables 2 and 3 show how the addition of thiodiphenylamine markedly increased the toxicity of diesel oil.

Comparison was made between a freshly mixed suspension of thiodiphenylamine in diesel oil and the supernatant liquid from a similar mixture that had stood for 24 hours, table 3.

It would appear from the results shown in table 3 that there is little difference over a period of several hours between the supernatant liquid and a fresh suspension of diesel oil and thiodiphenylamine. These results, however, may have a practical significance as a suspension would probably, in the absence of adequate agitation, vary in strength, and again there would be the possibility of a clogging of the nozzles of the spray guns, difficulties that would be obviated by using an oil without suspended matter.

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TABLE 1

Initial experiments with thiodiphenylamine as a larvicide. Started at 11:30 A. M.

DISH	MATERIAL	PERCENTAGE LARVAE DEAD AT							
		1:45 p.m.	4:45 p.m.	5:45 p.m.	6:45 p.m.	9 a.m.	11 a.m.	1:30 p.m.	4 p.m.
1	Check (Water)				10	10	10	10	10
2	1 drop kerosene		10	10	20	30	30	30	30
3	Thiodiphenylamine		30	30	100				
4	Thiodiphenylamine 1 drop				90	100			
5	Thiodiphenylamine and kerosene	20	100						
6	2 drops kerosene	60	70	70	70	70	70	70	70
7	2 drops thiodiphenyl-amine and kerosene	100							
8	Thiodiphenylamine 5% road dust 95%	10	100						
9	Thiodiphenylamine 5% road dust 95%	20	100						
10	Thiodiphenylamine 5% road dust 95%		80	80	100				

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TABLE 2

Comparison of toxicities of diesel oil and diesel oil-thiodiphenylamine. Experiment 32, started at 10:45 A. M. with 100 larvae to each dish.

Dish No.	Surface Area, sq. Cms.	Material	Cc. Used	Per cent dead at 1:30 p.m.	3 p.m.	4 p.m.	10 a.m.
1	800	Diesel oil	.5	1	9	16	66
2	721	Diesel oil + 5% acetone solution of TDPA	.5	22	60	88	99
3	804	Diesel oil + 3% acetone solution of TDPA	.5	18	67	83	98
4	725	Diesel oil + 1% acetone solution of TDPA	.5	14	35	53	92

TABLE 3

Dish No.	Surface Area, sq. Cms.	Material	Cc. Used	Per cent dead at 11:45 a.m.	1:45 p.m.	2:45 p.m.	3:45 p.m.	4:45 p.m.
5	800	Diesel oil alone	.3	6	10	22	40	55
1	800	Supernatant liquid from 100 cc. diesel oil + .5 grams TDPA	.3	47	89	98	99	100
2	721	Fresh suspension of 100 cc. diesel oil and .5 grams TDPA	.3	21	67	84	90	97

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The addition of even a small amount of thiodiphenylamine to diesel-engine oil increases its toxicity to a noticeable degree, as was shown also in table 2.

Conclusions - From these preliminary observations, it appears possible that the addition of thiodiphenylamine to a mosquito oil will, by increasing its toxicity, enable economies to be made in the quantities of oil necessary to cover a given area without the sacrifice of efficiency.

NOTE - Experimenters may obtain samples of Thiodiphenylamine (Phenothiazine) by addressing requests to the Pest Control Research Division Grasselli Chemicals Department, Du Pont Experimental Station, Wilmington, Del.

CERTAIN TECHNICAL ASPECTS OF "FREON" REFRIGERANTS OF INTEREST IN RELATION TO REFRIGERATION RESEARCH

EDITOR'S NOTE:-In the October, 1936, issue of this publication, Mr. Thompson discussed the safety properties and some other characteristics of "Freon" refrigerants. Additional data are given here. Owing to space limitations, this paper will be concluded in an early number.

By R. J. Thompson,
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Kinetic Chemicals, Inc.,
Wilmington, Delaware.

For many years recognition has been given to the economic importance of mechanical refrigeration for the preservation of perishable foodstuffs in storage. More recently, attention has been given to the development of mechanical refrigeration for the protection of commodities in transit. There have been several other applications of refrigeration in connection with storage, as in the case of storing furs, for instance. Refrigeration also is essential to certain industrial purposes, including the manufacture of kinds of chemical products. In some instances, extremely low temperatures are required in the chemical industry. There is one case, at least, where a temperature of 100 degrees, below zero, Fahrenheit, is maintained constantly.

There is, of course, at present growing popular interest in the importance and necessity of air conditioning for commercial, industrial and comfort cooling purposes. Air conditioning consists not only of the proper distribution and cleaning of the air, but also the proper control of temperature and humidity, as the occasion demands. That part of air conditioning that we as a society are mostly concerned with is the cooling and dehumidification of the air when control is required. True air conditioning offers really proven, widely accepted values. It is a tremendous contribution to human health and comfort; in industry it permits many improvements in processes and products and economies hitherto impossible; while commercially, such as in restaurants, theatres, hotels and stores, it pays big dividends in increased patronage, consumer good will and employe efficiency. Summer or year 'round air conditioning is not complete, unless it includes cooling and dehumidification by means of refrigeration equipment.

While refrigerating equipment that was efficient in operation long has been available--though, naturally, steadily improved --, it was not until less than seven years ago that really safe all-purpose refrigerants were obtainable. A factor that tended to stimulate research to develop safe and dependable refrigerants was the progress being made in the development of air conditioning.

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Research Develops New Refrigerants

Recognizing the necessity for refrigerants which would be safe and dependable at all times and under all conditions of use, extensive research was carried on, with the result that the "Freon" group was developed. These refrigerants are not by-products of any chemical plant, and, as has been indicated, they were not chance discoveries. They were introduced in 1930.

The group consists of: "Freon-12", dichlorodifluoromethane, CCl_2F_2, the most prominent member and used in reciprocating type compressors; "Freon-114", dichlorotetrafluoroethane, $C_2Cl_2F_4$ and "Freon-21", dichloromonofluoromethane, $CHCl_2F$, used in rotary type compressors and "Freon-11", trichloromonofluoromethane, CCl_3F, which is used in centrifugal type compressors.

Odor

The "Freon" group of refrigerants are odorless at concentrations of less than 20% by volume in air, which is equivalent to the release and vaporizing of 53 lbs. of "Freon-21", 63 lbs. of "Freon-12", 72 lbs. of "Freon-11" and 89 lbs. of "Freon-114" liquid into a confined space of 1,000 cubic feet. At concentrations higher than 20% by volume in air, the odors of these refrigerant vapors are very mild and somewhat ethereal.

The vapors in all proportions are non-irritating to the eyes, nose, throat, lungs and skin and being both odorless and non-irritating will eliminate all possibilities of a panic hazard occurring should the vapor or liquid escape from an air conditioning, commercial, industrial or household system.

Refrigerating systems that have been installed, whether they are of the small household size or larger air conditioning installations, would not produce a sufficient concentration of vapor-air mixture to be detected by smell should the entire charge of refrigerant be released into the kitchen or the entire building.

Toxicity

It is now known that "Freon-12", "Freon-114" and "Freon-11" are less toxic than, and "Freon-21" is almost equal to, carbon dioxide. This is a remarkable fact, as prior to April, 1930, it was not known to the scientific public or the refrigeration industry that there were gases possessing valuable properties that were less toxic than carbon dioxide.

It is a well-established fact that "Freon-12", "Freon-114" and "Freon-11" as such, are the least toxic refrigerants that have yet been discovered and complete and detailed data on toxicity is available in the Underwriters' Laboratories' report MH-2256 (Report on Dichlorodifluoromethane - "F-12"), MH-2375 (Report of Comparative Life, Fire and Explosion Hazards of Common Refrigerants) and MH-2630 (Report on Dichloromonofluoromethane - "F-21").

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The following is quoted from Underwriters' Laboratories' report MH-2375:

"Dichlorodifluoromethane appears to show no toxic effects in concentrations up to at least 20% by volume (63 lbs. per thousand cubic feet of space) for durations of exposure of the order of 2 hours. In tests with concentrations of the order of 28.5 to 30.4% by volume (89.6 to 95.7 lbs. per thousand cubic feet of space) for durations of exposure of the order of 2 hours, some physiological action is apparent, but whether or not this is caused primarily by oxygen deficiency is not shown by our data."

Undoubtedly, the large amount of "Freon-12" that was used to cause the apparent physiological action reduced the oxygen content of the test room from 20.5%, which is considered normal, to 14.25%, which is below the amount required to sustain life for long periods. It must be pointed out that when approximately 90 to 95 lbs. of "Freon-12" liquid is released into a hermetically sealed space of 1,000 cubic feet capacity, that suffocation may occur due to the fact that sufficient oxygen does not exist to sustain life. Ninety to 95 lbs. of "Freon-12" vapor in a 1,000 cubic foot space does not cause a toxic condition or one where the human system is poisoned. Thus, it is necessary to distinguish between suffocation and toxicity.

In the United States Bureau of Mines' report RI-3013 (Toxicity of Dichlorodifluoromethane - A New Refrigerant), it is reported that animals lived for an indefinite period of time in an atmosphere of 20% "Freon-12" vapor (63 lbs. per thousand cubic feet). In fact, pregnancy and bearing normal young were as frequent among animals exposed to "Freon-12" as among the controls. Also, that autopsies performed on all animals revealed no gross pathology attributable to exposure to "Freon-12". This same report states that "Freon-12" appears to be in a class of practically non-toxic gases. "Freon-12" has been placed in Group 6 by the Underwriters' Laboratories.

"Freon-114" toxicity tests by the United States Bureau of Mines will be found in their report RI-3185 and by the Underwriters' Laboratories in report MH-2375, previously mentioned. "Freon-114" has been placed in Group 6 by the Underwriters' Laboratories.

"Freon-11" toxicity tests by the Underwriters' Laboratories will be found in their report MH-2375 and has been placed by them in Group 5 with carbon dioxide.

"Freon-21" toxicity tests by the Underwriters' Laboratories will be found in their report MH-2630 and has been classified by them as much less toxic than Group 4, but somewhat more toxic than Group 5.

In these various reports it will be observed that all tests were conducted in hermetically sealed test chambers without ventilation and under the most severe of laboratory test conditions, which are not found under any habitable condition. Under habitable conditions the ordinary building construction would permit "Freon-12" vapor to flow under the doors and through cracks and crevices so that a great deal more than the stated quantities of refrigerant vapor would

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be required. When doors are opened, "Freon-12" vapor flows out very much like water.

The results of tests by the United States Bureau of Mines and the Underwriters' Laboratories, both of which are non-commercial and unbiased laboratories, should be sufficient evidence that the members of the "Freon" group of refrigerants mentioned in the foregoing will cause no toxic or suffocation hazard under any habitable condition.

Flammability and Explosiveness

"Freon" liquid or vapor is non-flammable and non-combustible, as "Freon"-air mixtures are not capable of propagating a flame for the reason that they contain no elements which will support combustion, and as a result do not endanger either life or property, in fact, several of these fluorinated compounds may be employed for fire extinguishing purposes as they are equivalent in this respect to carbontetrachloride, the fluid used extensively in hand operated fire extinguishers.

The United States Bureau of Mines has issued a pamphlet RI-3042 which shows the flame extinguishing properties of "Freon-12" to be equal to carbontetrachloride, almost 2-1/2 times as good as carbon dioxide, more than 4 times as good as nitrogen (the yardstick of non-flammability), 4-1/2 times as good as helium (the safe stratosphere balloon gas) and almost 7-1/2 times as good as argon. They have found "Freon-12" to be far better in rendering methane or other combustible gases, vapor or solids less flammable than any of the other gases mentioned above.

The following paragraphs are quoted from the Underwriters' Laboratories' report MH-2256:

> "No evidence of flame propagation was observed in any dichlorodifluoromethane vapor in air mixture when tested in the chamber either at room temperature or at an initial temperature of 100°C. (212°F.). Both the electric spark and the illuminating gas flame were used as sources of ignition - no evidence of an explosive reaction (rise of pressure) was recorded by the Crosby indicator in any of the tests."
>
> "No apparent ignition of dichlorodifluoromethane was observed up to 750°C. (1382°F.)."
>
> "Dichlorodifluoromethane is a non-combustible and non-flammable refrigerant."

The following is quoted from the Underwriters' Laboratories' report MH-2375:

> "Carbon dioxide, carbontetrachloride, dichlorodifluoromethane ("Freon-12"), dichlorotetrafluoroethane ("Freon-114"), trichloromonofluoromethane ("Freon-11") and sulfur dioxide differ widely from each other in chemical properties, but are alike in not being capable of propagating flame and are classed as non-combustible and non-flammable."

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The following is quoted from the Underwriters' Laboratories' report MH-2630:

> "Dichloromonofluoromethane ("Freon-21") is practically non-flammable and non-explosive at ordinary temperatures, but at higher temperatures, under favorable laboratory test conditions is capable of forming weakly combustible mixture with air. Formation of combustible mixtures by dichloromonofluoromethane ("Freon-21"), however, under practical conditions even at higher temperatures is extremely unlikely, and its fire hazard is therefore very small."

"Freon-21" has the same classification as methylene chloride (dichloromethane) from a comparative fire and explosion standpoint.

Since these refrigerants are non-flammable and non-combustible their use will eliminate all possibilities of a fire or explosion hazard even if they should accidentally escape from the refrigerating system.

Corrosion Properties

The "Freon" refrigerants are non-corrosive to all metals used in refrigeration apparatus; such as, steel, cast iron, brass, copper, tin, lead, zinc, aluminum, etc. and this feature permits the manufacturer a wide selection of materials from which he is enabled to design and produce the most efficient condensers, evaporators, compressors, control apparatus and pipe lines.

Magnesium alloys and aluminum containing magnesium are not recommended for use in "Freon" charged systems where water may be present, as corrosion will result. The water of water vapor has a high corrosive effect on such materials, but this corrosion is neither accelerated nor retarded by the presence of "Freon."

"Freon" has a high solvent action on natural rubber binders used in compounded and molded packing and sheet gasket materials, but the development and use of new synthetic rubber has been found entirely satisfactory, after very severe actual operating conditions.

The "Freon" refrigerants are stable and inert and will withstand repeated evaporations, compressions, and condensations without disassociation, even under the most abnormal of operating conditions.

Any type of system, regardless of the refrigerant used should be dry and especially so in the case of "Freon" in order to eliminate the possibility of moisture freezing out at the regulating valve, intercrystalline embrittlement of brass bellows or diaphragms under cyclic stress, shorting of field coils in hermetically sealed units and emulsification of the lubricating oil, any one of which might cause faulty operation of the system. It is to be pointed out that water which may be in the "Freon" system together with air will cause oxidation of metal parts which must be distinguished as oxidation and not refrigerant corrosion.

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Effect on Foods, Flowers, Furs and Fabrics

"Freon" liquid or vapor is not absorbed by and has no effect on any materials being refrigerated and their vapors have no effect upon the odor, taste, color or structure of dairy products, meats, eggs, vegetables, etc. Has no effect upon the odor, color, continued blooming or structure of flowers or plant life and the liquid or vapor has no effect upon the color or structure of furs or fabrics.

Decomposition of Common Materials

Everyone should realize that when an organic compound is exposed to high temperature that it will decompose into other chemicals. This is the simplest of elementary chemistry.

The following is quoted from "Gases from Thermal Decomposition of Common Combustible Materials" which appeared in Industrial and Engineering Chemistry, Vol. 25, page 599 of June, 1933:

> "The gases from all types of fires investigated contain toxic constituents in sufficient amount to make breathing the gases dangerous or even fatal in a relatively short period. Gases from different materials differ greatly in toxicity. Substances containing nitrogen or sulfur, or both, produce the most toxic gases."

Such materials that were tested were newspapers, wood, gasoline, rubber insulation, wool, silk and many others, and produced such toxic or dangerous gases as carbon monoxide, hydrogen sulfide, sulfur dioxide, ammonia, hydrocyanic acid, nitrogen oxide and others.

Even common table salt will decompose into muriatic acid, which is capable of removing porcelain from kitchen sinks or toilet fixtures, and caustic soda (lye) which is quite capable of removing varnish from a wooden floor.

Are these common materials, which are necessities of our modern civilization, to be condemned and barred from further use simply because they decompose when exposed to flames under high temperatures of laboratory test conditions? What of the foods we eat, clothes we wear, homes and buildings we live and work in, furniture we use? Is there any material known that will not decompose when subjected to sufficiently high temperatures? Even carbon dioxide, under certain conditions, will break down into a very poisonous gas - carbon monoxide - and every chemist knows these conditions are absence of air or oxygen, high temperature and in the presence of carbon.

Conditions Necessary for Health Hazard

All organic compounds used as refrigerants decompose into their halogen acids on passage through a naked flame of high temperature, but the conditions required

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to produce decomposition products that might produce a health hazard are:

1-There must be a refrigerant leak in the system.
2-There must be a leak of large quantities of refrigerant.
3-There must be a very rapid leak of large quantities of refrigerant.
4-The refrigerant must leak into a confined, non-ventilated or hermetically sealed space.
5-There must be an open flame in the confined space.
6-There must not be stew pans containing water on the gas flame which would absorb acids.
7-There must be a fan for circulating the heavy refrigerant from the floor into the gas flame.
8-There must be sufficient time allowed to permit large quantities of the refrigerant in the confined space to pass through the flame to be decomposed and become irritating.
9-There must be a person in the confined space who could not detect the presence of the decomposition products.

There is not even a remote possibility that these nine conditions could occur simultaneously, other than, under laboratory test conditions.

The Underwriters' Laboratories' report MH-2375, in part, reads:

"In the presence of flame and very hot surfaces (550°C.), dichlorodifluoromethane and dichlorotetrafluoroethane are decomposed, with the formation of toxic products, which are exceedingly irritating, and therefore give adequate warning of their presence in the air even in concentrations of very low order. The danger from the fumes depends upon the concentrations and duration of exposure, but under ordinary conditions, except in unventilated places, serious danger to life is not involved, as pointed out, page 108.2.

"It is to be noted, however, that in the presence of open coil hot resistance wire units such as are used in electrical ranges for cooking, even when heated to a cherry red heat (750°C.), practically no toxic decomposition products are formed during a period of exposure of the order of 1/2 hour in a room without any ventilation."
(Page 116, column 1, paragraphs 5 and 6)

"The conditions maintained in the test were severe. Neither the test conditions nor the concentrations used can be asserted to be those which will exist in any given enclosure since the size of such enclosure, the ventilation and other variables are controlling factors. The data contained in this investigation, however, are comparable and serve as a practical measure of the comparative hazards of refrigerants under working conditions."
(Page 106, column 1, paragraph 5)

"It will be noted that in order to obtain an accurate basis for comparison the tests were conducted under conditions more severe than

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are encountered in practice. The test room is smaller than the average sized kitchen and no ventilation whatever is provided. Hence, effects shown by the tests are more severe than the effects obtainable under conditions to be anticipated in practice."

(Page 106, footnote '82')

Let it be clearly understood that a tightly closed room containing a flame is positively and inherently a lethal chamber regardless of the presence of or absence of a refrigerant gas. Furthermore, any test should hinge upon the worst conditions actually tolerated by people in rooms containing open flames and not on that which can be obtained in hermetically sealed test chambers or rooms.

Such a test room would not be habitable even if there were no refrigerant vapors present and would be a lethal chamber, due entirely to the lack of ventilation and inability to maintain a normal oxygen content of 20-1/2%. Such a test room would be suitable only for laboratory conditions and not of a habitable nature even under the most abnormal of conditions.

Limitation of Decomposition

The "Freon" family of compounds in common with all halide gases will decompose on passage through a naked flame, but only that portion which actually passes through the flame is decomposed into its halogen acids as previously pointed out. The decomposition products can be obtained only where there is rapid leak of large quantities of liquid refrigerant into a confined space where there is no ventilation, where there are large gas flames in the room and where there is a circulating fan which will drive the heavy "Freon" vapor (3.56 to 6.0 times heavier than air) through the gas flame.

The decomposition of "Freon" vapor is not spontaneous or progressive with the result that sufficient time must be allowed for the vapor to be decomposed and become pungent and irritating. Should there be decomposition products, they will prove to be their own warning agent, as they are noticeable in minute quantities and will cause any person present to immediately ventilate the room merely by opening the door or window. The warning power of the decomposition products will prevent prolonged exposure before concentrations dangerous to health are reached. The decomposition products are readily dissolved by water from automatic sprinklers or hose streams.

Do not confuse the odor or irritating products of decomposition of the refrigerant with concentrations that might be considered harmful. Also you must distinguish between combustion products of the flame and the decomposition products of the refrigerant vapor.

This subject of decomposition applies not only to the "Freon" family of refrigerants, but to all other refrigerants, some of which have been commonly used for a great number of years and in fact, this applies to all chemical compounds or materials. Gases from decomposition of the various materials differ greatly in toxicity with those materials containing nitrogen or sulfur, producing the most toxic compounds.

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The best evidence of the safety of the "Freon" refrigerants in actual service, is that approximately 12,000,000 lbs. of "Freon" have been used in refrigeration equipment - a large portion of which was placed in household units. Many household units which leaked were installed in kitchens adjoining gas fire ranges, but there has never been a record of complaint from any user relative to decomposition products. This is a very important fact that must not be overlooked.

"Freon" is a trade mark registered in the U. S. Patent Office by Kinetic Chemicals, Inc., Wilmington, Delaware.

SOME OBSERVATIONS ON TREATING COTTON SEED WITH DESCRIPTIONS OF THE METHODS FOLLOWED

EDITOR'S NOTE:- This popular discussion of cotton seed treating, written for "The Cotton and Cotton Oil Press," is reprinted for such use as county agricultural agents and others may have for the information when contacting growers of cotton.

By: H. C. Bucha, Plant Pathologist,
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The disinfection of cotton seed used for planting purposes now is established as an important aid to profitable cotton production. The preliminary stages of experimentation and trial are a matter of history. First tried nearly ten years ago by several experiment stations, the treatment of cotton seed produced rather remarkable increases in stand and yield. Lack of ready cash during depression days retarded somewhat the general adoption of the practice, but now, with cotton incomes on a more profitable level, growers are turning their attention enthusiastically to better methods of deriving greater profits from their cotton acres.

The reasons for this greatly accelerated interest in cotton seed treatment are not hard to understand. They are to be found in the published data of experiment stations, the results of demonstrations by extension specialists and county agents, and in the many years of observation and experience with seed treatment by cotton breeders and farmers. Average figures typical of those secured from numerous farm tests by various investigators show improvements in stand of 25 to 75% before chopping; 10 to 30% after chopping; and increases in yield ranging from 10 to 20%. It should be remembered that these figures are averages, and that for individual tests increases in stands and yields have ranged from zero to 200% or more.

The December 1936 issue of The Southern Planter reports Dr. Luther Shaw of the North Carolina Agriculture Extension Service as saying that, "13 demonstrations conducted in Chatham, Lee, Cumberland, Moore and Anson Counties, indicated that cotton raised from treated seed produced heavier yields than that raised from non-dusted seed.

"The cost of dusting amounted to approximately 20 cents an acre, while the yield increased by 49 to 321 pounds of seed cotton, with an average of 156 pounds per acre for the 13 demonstrations."

Results of Laboratory Tests

But that's the end of the story; and a happy ending it is. To begin at the beginning, let's step into the laboratory for a moment and look at some cotton

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seeds germinating. Five days ago these seeds were placed in the germinator trays. At the time of our visit they are beginning to push out leaves and roots. But something else is happening too. Almost every seed is covered with a growth of mold. In some cases the molds are as flimsy and delicate as a spider web; in others, the mold is a compact mat almost like a piece of felt.

These molds, technically known as fungi, have developed from microscopic bodies called spores. For simplicity of explanation we can say that spores are the seeds of molds or fungi, for it is by means of them that molds reproduce themselves, just as the wheat plant reproduces itself by means of seed.

Examined with a microscope, it would be difficult to find a cotton seed which did not have at least a few spores on the seed coat or entangled in the lint, for they are present in the air, in the soil, on the cotton foliage and bolls, and in the warehouses; they are omnipresent. Many thousands may be attached to a single seed.

These fungi and their spores are of many different kinds. Some are entirely harmless to the cotton seed and plant; others are capable of causing serious injury and even death to the seed and seedling; still others attack the foliage and bolls. It is in these two latter classes of disease-producing fungi that we are interested.

Before going back to the field with our investigation, let's examine some of these other trays. Here's one just beside the first, and strangely enough, there are no molds growing on the seed. No one will blame you for being a bit skeptical when you are told this lot of seed came from the same sack as that moldy lot in the first tray. But examine them carefully, for in the difference of the appearance of the seed in those two trays lies the explanation of that average increase in yield of 156 pounds of seed cotton per acre in Shaw's North Carolina demonstrations.

The seed in the second tray was disinfected before being placed in the germinator tray; the seed in the first tray was not disinfected. The disinfection process was carried out by simply dusting the seed with a small amount of a chemical known as ethyl mercury chloride. As soon as it was applied to the seed, it began to throw off a vapor or gas, toxic or poisonous to the spores. In a short time the spores were all dead and naturally when this treated seed germinated, no molds appeared on it. On the untreated seed, however, the spores germinated under the warm, moist conditions in the trays and soon developed into the mass of molds, which we saw over-running the seed.

Things Observed in a Field

Now suppose we step out into a recently planted field and see what is happening. The young plants have been up in the sunlight only a few days. Here's a 5-foot gap without a single plant. Maybe the planter failed to drop seed, but, no, here we've dug up the remains of several seeds--all rotted. Those rotted seeds are the practical result of what we saw in the laboratory. Some of those same

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sorts of molds we saw growing on the untreated seed in the germinator tray have attacked the seeds germinating in the soil, and, sad to relate, the seeds have lost the battle. Incidentally the cotton grower has lost some cotton and with it some of his profit.

Walking down the row of cotton seedlings we observe a good many seedlings that have given up the fight and toppled over. Every one of them shows a dead area on the stem near the soil line. That's sore-shin or damping-off, and those rascally fungi or molds are the villains again.

Our curiosity as to the stunted, yellowish appearance of some seedlings prompts us to pull them up. It's not hard to understand the trouble; the root system has never developed or has rotted off. Those molds, again? You're right.

Those rotted seeds, those dead and weak or stunted plants are usually good evidence that the molds have won another battle and that the cotton grower must grin, if he can, and bear the losses. Had those tiny, but dangerous, fungous spores on the seed been destroyed instead of being planted with the seed, much of this loss could have been prevented. That's where seed treatment fits into the picture. By dusting the seed with a suitable disinfectant we can eliminate with very little trouble and expense many of these seed-borne fungous enemies which cause poor stands and lowered yields. Elimination of them is the simple explanation for the improved stands and increased yields which usually result from seed treatment.

Let no cotton grower think his seed is free from these fungous parasites. A simple germination test of his untreated seed on wet newspaper or cloth almost certainly will show the development of those tiny enemies of the cotton crop. And just as surely, if he will germinate treated seed, he will find few, if any, of those molds developing.

Treatment and Seed Treaters

So much for theory and explanation. Now for the practical use of this knowledge. First, the disinfectant most commonly used is a diluted dust containing 2% ethyl mercury chloride, a chemical combination of carbon, hydrogen, mercury, and chlorine.

For non-delinted seed it should be applied at the rate of three (3) ounces of the dust per bushel of seed. For delinted seed two (2) ounces per bushel is sufficient. The treatment may be applied at any convenient time after the seed is well cured, and the treated seed may be stored in bulk or in sacks until planting time.

For treating up to a hundred bushels an ordinary rotary seed treater made from an oil drum, equipped with an axle and mounted on sawhorses, is very convenient and should last a lifetime. Directions for making one of these can be secured from the state colleges or from manufacturers of seed disinfectants.

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In the absence of such a treater, a discarded calcium arsenate drum can be used. Fill the drum not over half full of seed, add the correct amount of dust, replace the cover of the drum and roll it over the ground for two minutes.

When large amounts of seed are to be treated, commercial seed treating machines are more satisfactory. They can be adjusted to treat 60 sacks of seed or more per hour. They are continuous in operation, the seed and dust entering at one end and the treated seed emerging through a 2-way sacker at the discharge end.

The sort of treater to select--a drum to be rolled over the ground, a rotating drum mounted on sawhorses, or a more elaborate, power driven machine of the continuous-treating type--will depend largely on the amount of seed to be treated, the number of bushels to be treated per hour, and the cost of labor. Without going into further details on the mechanics of the operation, it need only be said that the dusting of the seed is exceedingly simple and easily carried out on any farm.

Treatment is Not a Cure-all

By controlling the seed-borne diseases of cotton through seed disinfection many growers have learned to avoid replanting and by reason of better stands and yields to reduce the cost of producing cotton. Seed treatment seems destined, therefore, to play a highly important role on cotton farms where its purpose is understood and appreciated. Like most other scientific discoveries cotton seed treatment has its limitations, which should be equally well understood and appreciated if the maximum benefit from the practice is to be secured. Hence, a word of precaution to the over-enthusiastic may not be amiss.

First, the disinfection of cotton seed is no panacea or cure-all for seed troubles. It does not take the place of careful breeding, selection, curing and cleaning of seeds. Rather it supplements these practices.

It does not breathe life back into dead seeds. While it is true that weak seeds are more apt to grow if treated than if left untreated, nevertheless, seed treatment should not be depended on to transform poor seeds into good seeds.

On the other hand, the mere fact that a given lot of seed germinates 95% in the laboratory is no indication that seed treatment is not necessary or advisable. Conditions in the germinator trays are quite different from those in the soil. Unfavorable weather and soil conditions at planting time have wrecked many a field of cotton planted to the highest quality seed. Fungi or molds are no respecters of breeding and quality in cotton seed; they attack with equal enthusiasm and with equally disastrous results, poor seed and good seed.

SOME INSOLUBLE COPPERS AS BORDEAUX SUBSTITUTES UNDER INVESTIGATION AT OHIO EXPERIMENT STATION

EDITOR'S NOTE:- The realized need for fungicides that would offer adequate protection against certain diseases without injury to plants long ago turned the attention of investigators to some of the insoluble coppers. The results of experiments encourage the belief that eventually some of the most destructive of plant diseases will be checked. There is, however, considerable research yet to be done. Laboratory and field work being carried on by the Ohio Agricultural Experiment Station, Wooster, Ohio, is attracting wide interest.

Bordeaux mixture is the most widely used fungicide for the control of plant diseases. However, it is injurious to the foliage of some plants and often checks the growth and yield of others, such as cucumber, muskmelon, and tomato. This is the case in a season of normal rainfall and evaporation rates, but in periods of drouth, such as we have had so frequently during the past six growing seasons, instances of injury to Bordeaux-sprayed plants have been frequent and severe. This type of injury is most common under conditions of low soil moisture and high evaporation, since Bordeaux mixture is capable of increasing the rate of water loss from plants to which it is applied. It may thus become the straw which breaks the camel's back by drying out tissues to such an extent that they cannot later recover, even though moisture conditions may again become favorable for growth, according to Dr. J. D. Wilson of the Botany Department of the Ohio Agricultural Experiment Station.

A Number Available

There are now a number of comparatively insoluble copper-containing compounds on the market which are very unlikely to be injurious and, because of this, are being advocated as substitutes for Bordeaux mixture on plants sensitive to the latter. The most common of these include such materials as various forms of copper oxychloride, copper ammonium silicate, copper hydroxide, basic copper sulfate, cuprous oxide, copper phosphate, copper resinate, copper stearate, copper zeolite, copper silicate, and various mixtures containing copper in the colloidal form. The ability of some of these compounds to check or prevent various plant diseases has not been sufficiently demonstrated, and for this reason they should not be depended upon too strongly as spray materials until they have been subjected to further trials.

Basic Copper Chloride

Copper oxychloride (basic copper chloride) has given encouraging results as a spray material for cucumbers, muskmelons, and tomatoes. Cuprous oxide (Cuprocide)

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and copper ammonium silicate (Coposil) also offer some promise as substitutes for Bordeaux mixture under special conditions. Many of the others listed above cannot yet be definitely classified in order of their fungicidal effectiveness. Some have failed to control such diseases as Alternaria blight of ginseng, leaf blights of carrot, early blight of tomato, and the early and late blights of celery. Bordeaux mixture, on the other hand, will, when properly used, give good control of this group of diseases.

NOTE: The Pest Control Research Division, Grasselli Chemicals Department, Du Pont Experimental Station, Wilmington, Delaware, will be glad to supply free samples of copper oxychloride for experimental purposes to research organizations.

DITCHING AND CLEAN-OUT WORK IN FLOODED AREAS CAN BE DONE QUICKLY AND CHEAPLY WITH DYNAMITE

EDITOR'S NOTE:- This brief and timely article offers suggestions which should be of interest and value in connection with efforts to put farm lands back in condition where damage has been caused by recent flooding.

By L. F. Livingston, Manager,
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Many thousand acres of our best agricultural lands are in drainage areas of river valleys, where throughout ages silt and top soil were deposited. These areas for the most part are interlaced with drainage ditches in order to make cultivation possible and profitable.

In the Ohio and Mississippi valleys, the recent high water carried an untold amount of solid materials. Naturally, as the water went down, the speed of the current decreased, and deposits of sediment were left; the closer to the main channel, the greater the deposit.

As a result of the flood, many drainage systems were entirely filled up. Others have obstructions in the main outlet channels entering the rivers. It is essential, therefore, that these plugs be removed, and speed is an important factor in reclaiming the land, or any other rehabilitation program.

Practical Suggestions

Blasting ditches and channels is a well known and common practice. Approved methods have been described in more or less detail in previous issues of the Agricultural News Letter. Several points, however, are generally overlooked, which make the use of explosives especially valuable for ditch and channel clean-out work. These are:

Speed -- All that is necessary is to put down holes of sufficient depth on proper spacing and load them with the right amount of dynamite adapted to ditching work. The only limit to the length of a ditch that can be blasted or cleaned in a given time is the man-power available to punch the holes and load the explosives. Usually, three men can make a quarter of a mile of ditch, 6 feet deep, in a day's time, using Du Pont Ditching Dynamite. By the propagated method, a ditch of almost any width, depth and length can be blasted in a single shot. These considerations also apply to clean-out work.

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Soft Mud is Easy to Blast -- Water-soaked soil is easy to ditch, and ditches filled with water can readily be cleaned out with explosives. This because the softer the mud, the more easily it can be blown out with dynamite.

Mobility of Explosives -- Due to the fact that dynamite, in any quantity, can be taken to any place a man can go on foot or in a rowboat, readily adapts the explosive to use in flooded areas. It is packed in 50-pound cases for ease in handling.

NOTE: Bulletins with diagrams, illustrations and complete descriptions of ditch blasting and clean-out methods are available. Also, the Agricultural Extension Section will be glad to make recommendations for any specific type of work.

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C O N T R I B U T O R S

Having as a principal purpose the presentation of reliable and timely information on agricultural developments and related topics, the AGRICULTURAL NEWS LETTER has been fortunate in being enabled to offer its readers authoritative discussions by the following contributors:

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